GB2231116

Publication Title:

Method for controlling an automatic friction clutch

Abstract:

Abstract of GB 2231116

(A) A method for controlling an automatic friction clutch operating between a drive machine 2 and a gearbox 4 for at least starting comprises moving the clutch to a closed from a disengaged position, but only enough so that the vehicle is not moved or so that the gear input shaft remains below the engine idling speed, detecting a parameter and feeding this to a memory 11 whereupon the clutch is opened again at least partially. The clutch operating mechanism 17 is operated by hydraulic cylinder 8 and hydraulic setting member 10. The memory 11 receives information about the speed of the engine 2, the speed of the gearshaft 12, the position of the cylinder 8, the position of a throttle valve 13, the operating temperature, the air temperature, characteristic values of the exhaust and fuel, and the position of the accelerator pedal 19.

(12) UK Patent Application (19) GB (11) 2 231 116 (13) A

(43) Date of A publication 07.11.1990

(21) Application No 9008500.2

(22) Date of filing 17.04.1990

(30) Priority data

(31)	(32)	(33)
3912562	17.04.1989	DE
3916644	22.05.1989	
3934541	17.10.1989	

(51) INT CL⁵
F16D 25/14

(52) UK CL (Edition K)
F2L LC L102 L103 L111 L112 L113 L114 L119 L129 L131 L132 L301 L302 L501

(56) Documents cited
GB 2173273 A GB 1337713 A

(58) Field of search
UK CL (Edition K) F2L
INT CL⁵ F16D

(71) Applicant
LuK Lamellen und Kupplungsbau GmbH

(Incorporated in the Federal Republic of Germany)

Postfach 13 60, 7580 Buhl,
Federal Republic of Germany

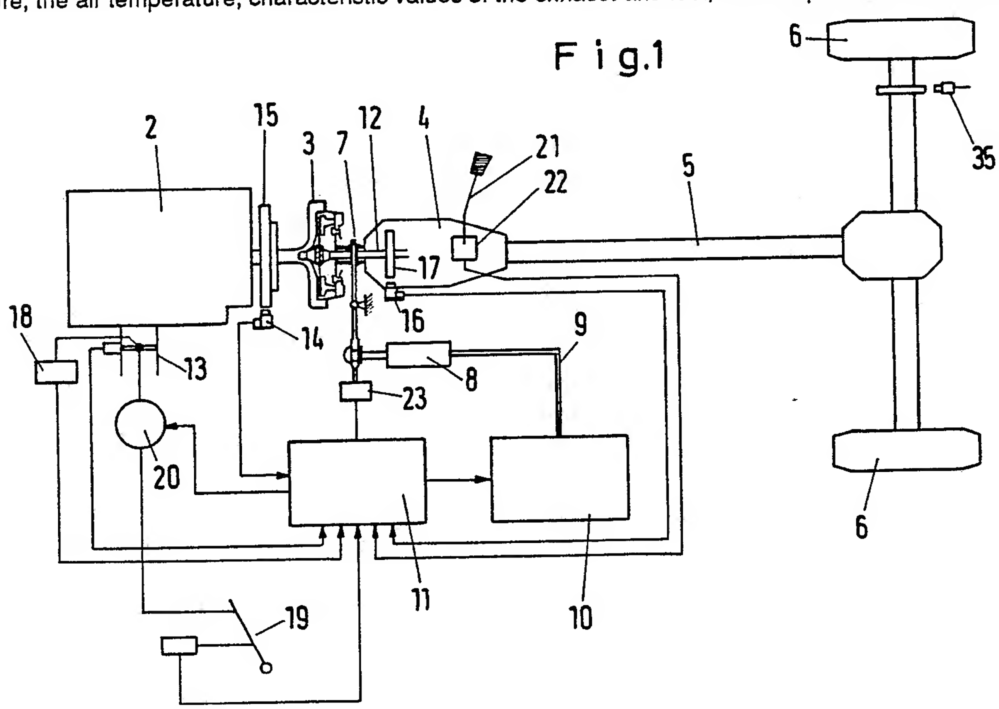
(72) Inventors
Wolfgang Reik
Paul Maucher
Louis Ferninand Schulte
Burkhard Brandner
Boguslaw Maciejewski
Jorg Holwe

(74) Agent and/or Address for Service
Dummett Copp & Co
14, The Square, Martlesham Heath, Ipswich,
Suffolk, IP5 7SL, United Kingdom

(54) Method for controlling an automatic friction clutch

(57) A method for controlling an automatic friction clutch operating between a drive machine 2 and a gearbox 4 for at least starting comprises moving the clutch to a closed from a disengaged position, but only enough so that the vehicle is not moved or so that the gear input shaft remains below the engine idling speed, detecting a parameter and feeding this to a memory 11 whereupon the clutch is opened again at least partially. The clutch operating mechanism 17 is operated by hydraulic cylinder 8 and hydraulic setting member 10. The memory 11 receives information about the speed of the engine 2, the speed of the gearshaft 12, the position of the cylinder 8, the position of a throttle valve 13, the operating temperature, the air temperature, characteristic values of the exhaust and fuel, and the position of the accelerator pedal 19.

Fig.1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 231 116 A

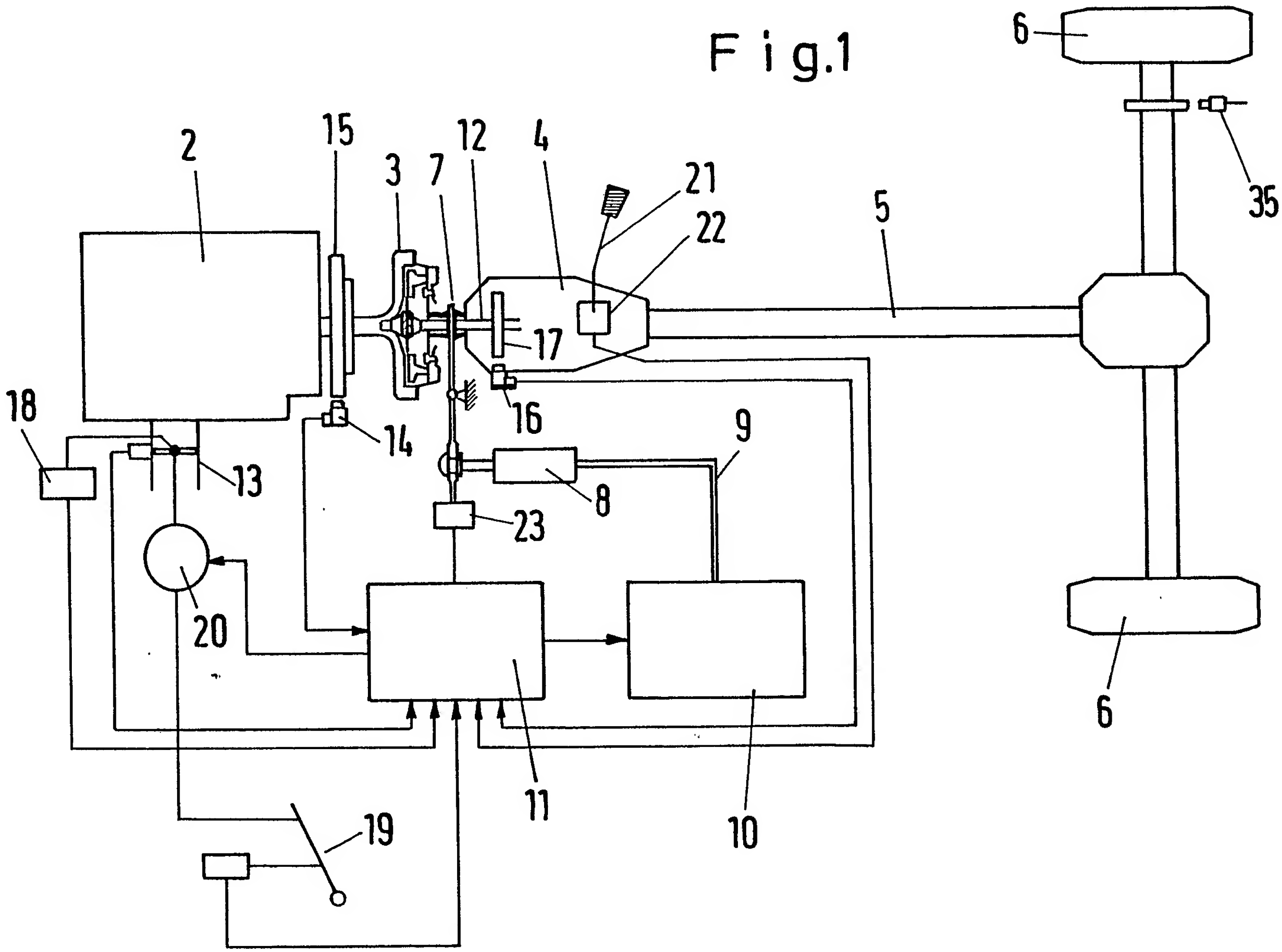
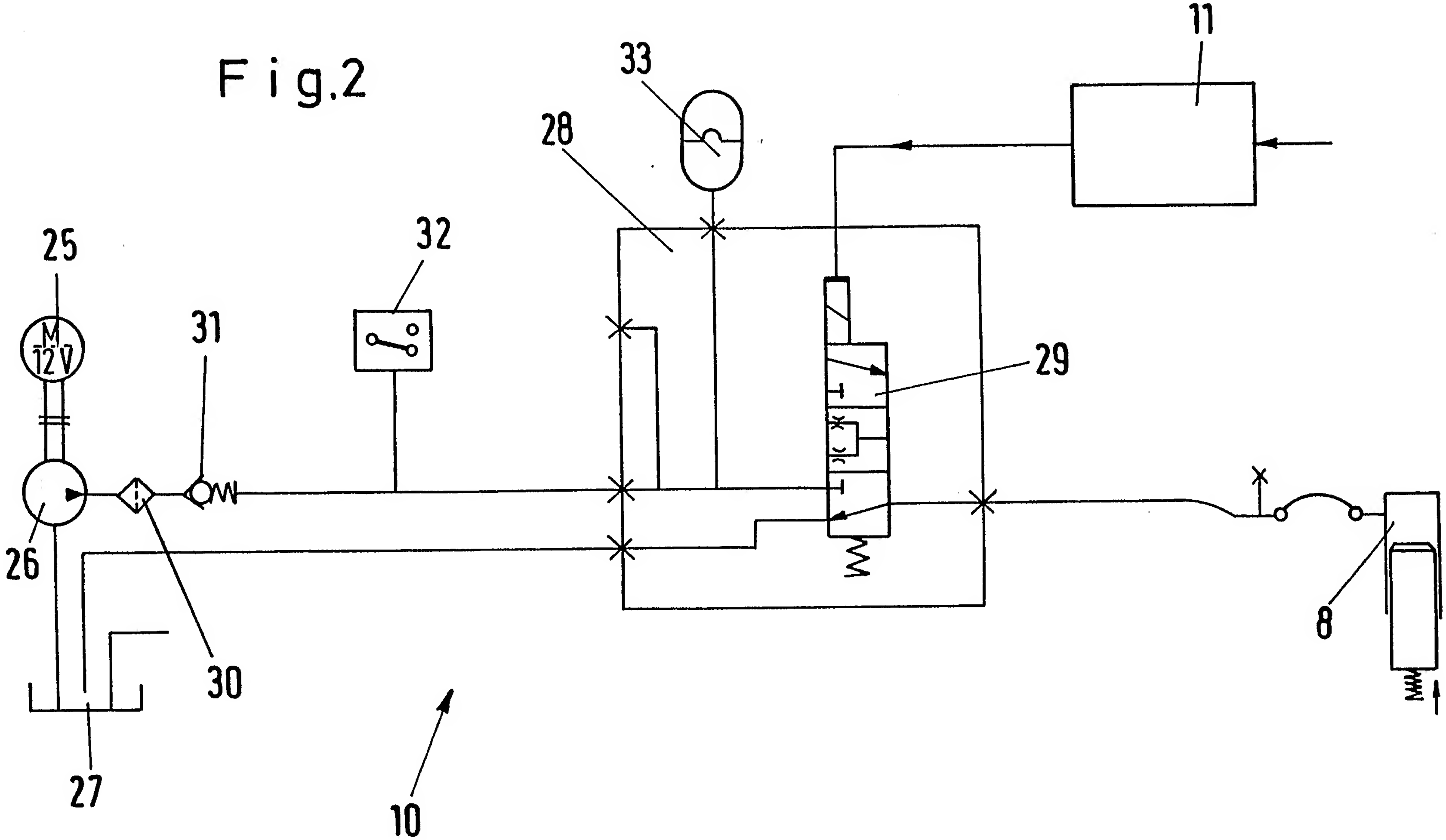


Fig.1

Fig.2



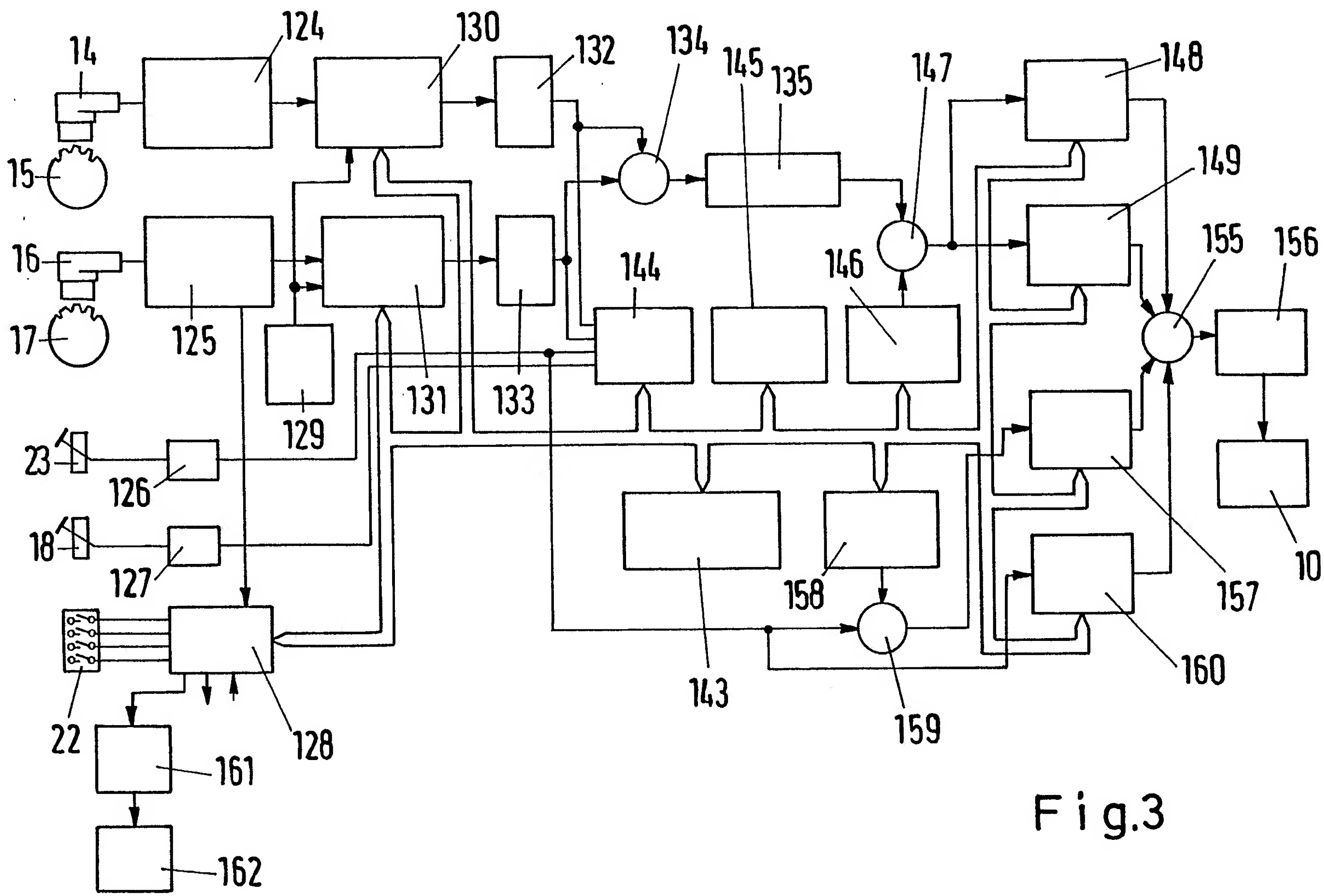

14
15
16
17
23
18
22
124
125
126
127
128
129
130
131
132
133
134
135
143
144
145
146
147
148
149
155
156
157
158
159
160
161
162
10

Fig.3

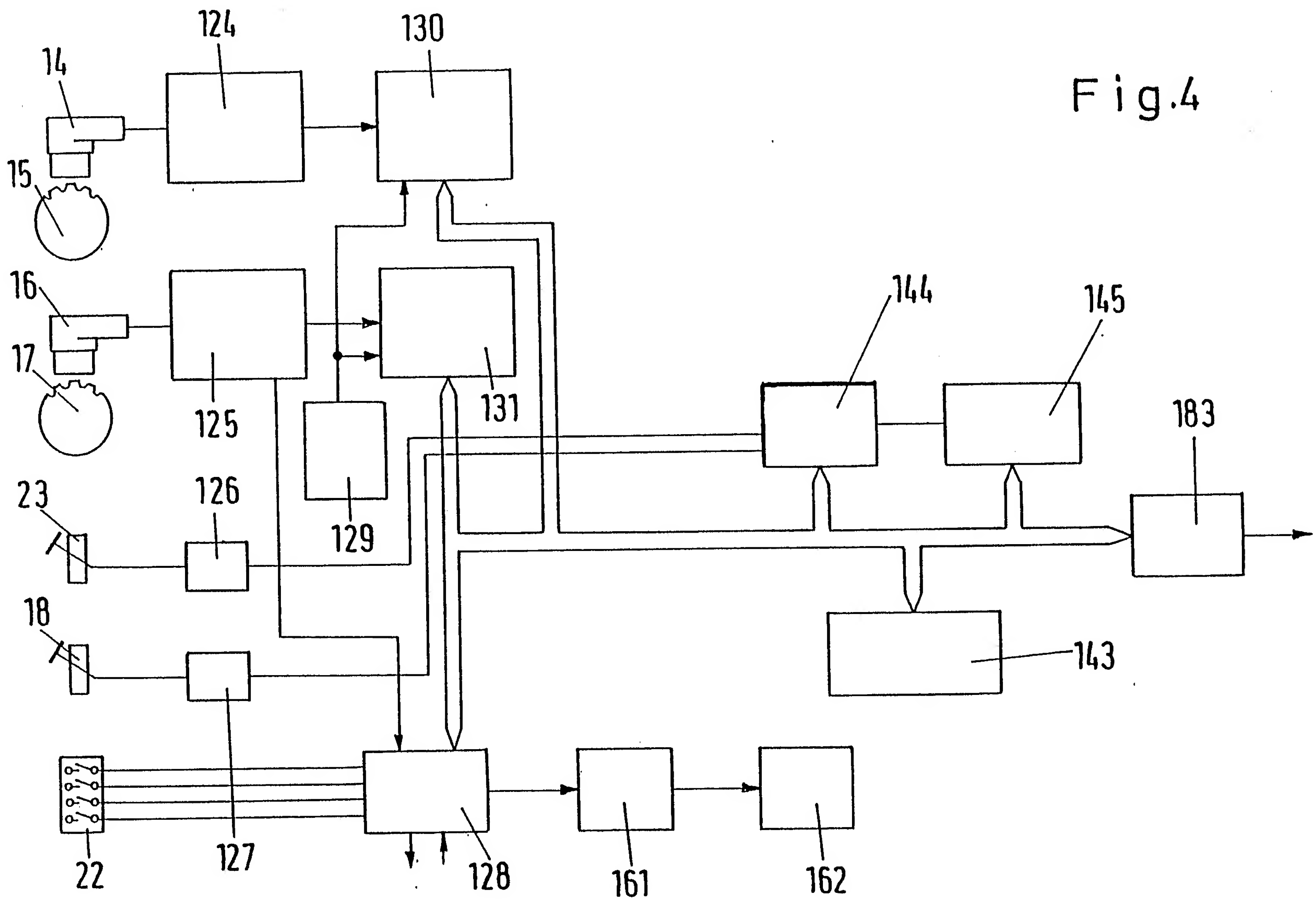

14
15
124
130
16
17
125
131
129
23
126
18
127
22
128
161
162
144
145
183
143

Fig.4

Fig.5

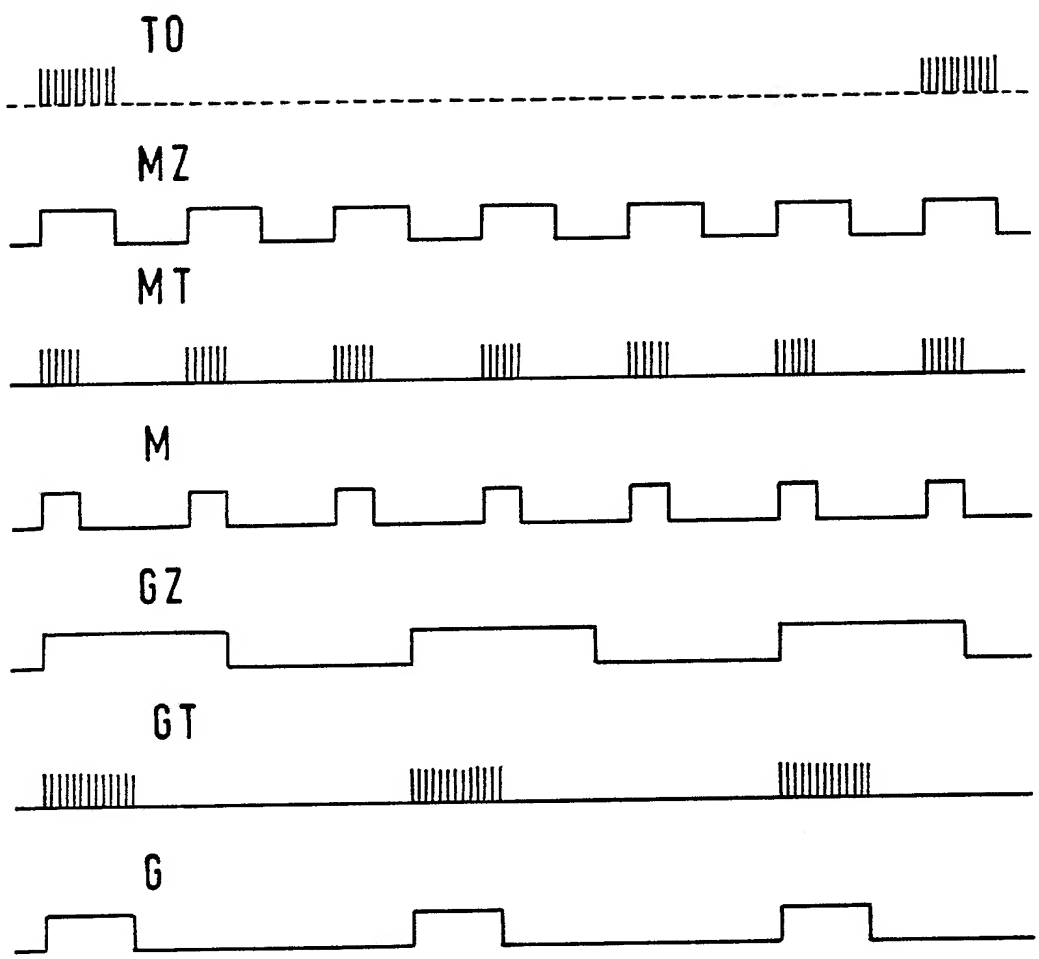


Fig.6

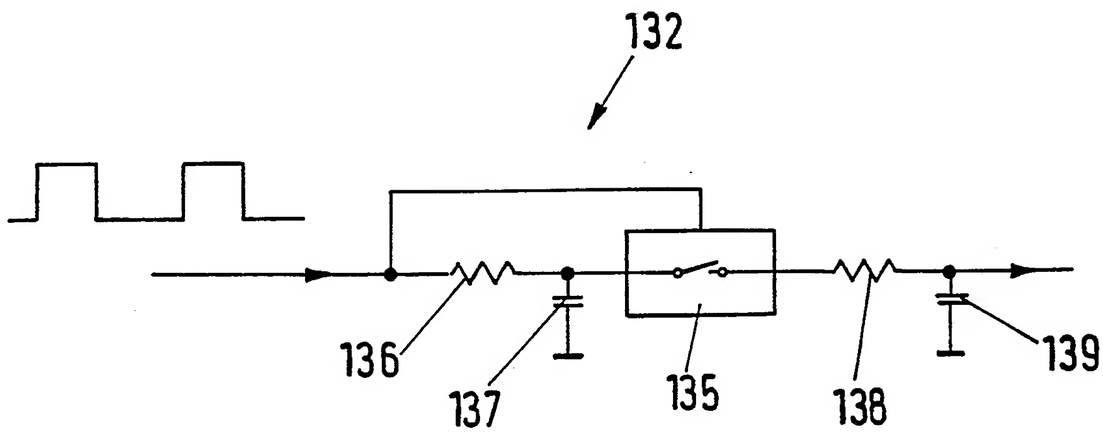
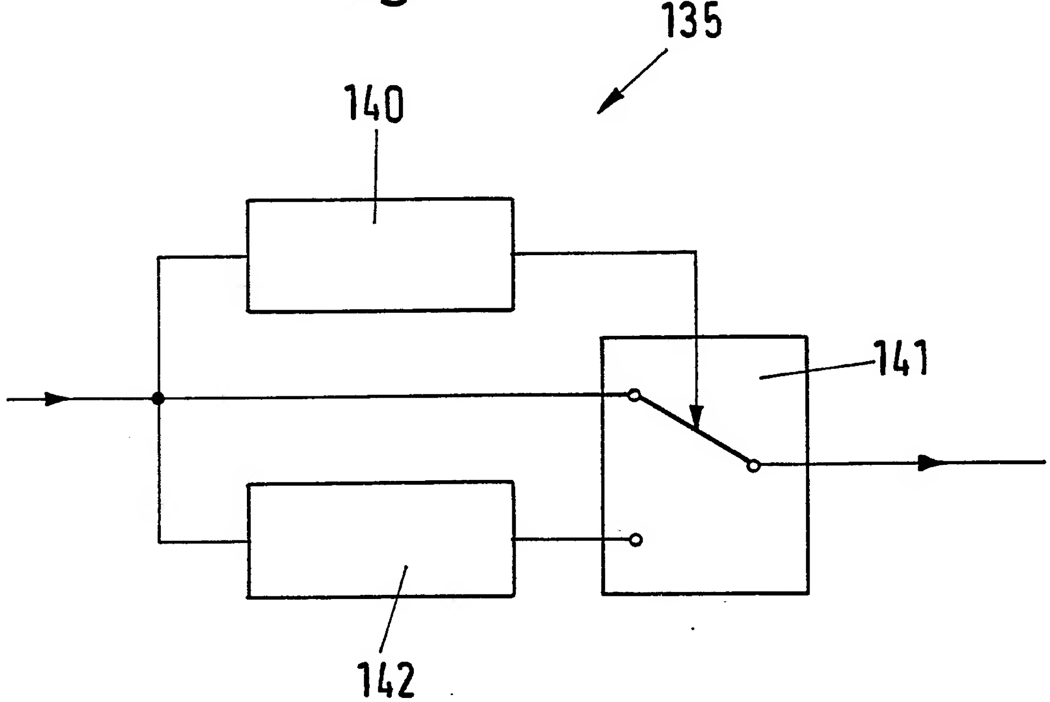


Fig.7



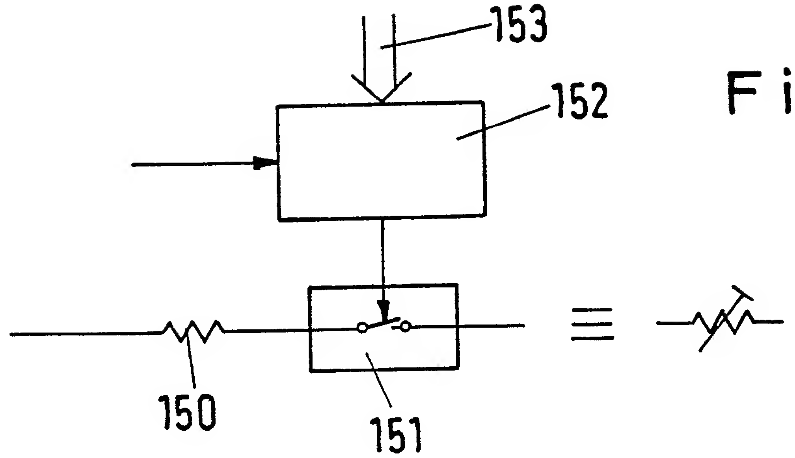


Fig.8

Fig.9

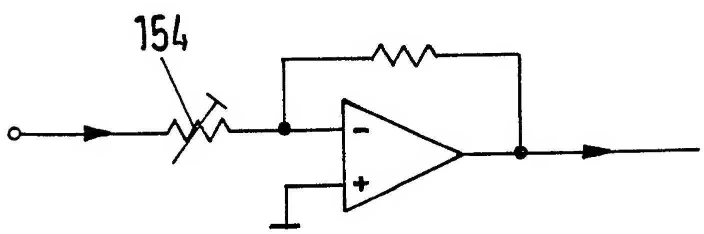


Fig.10

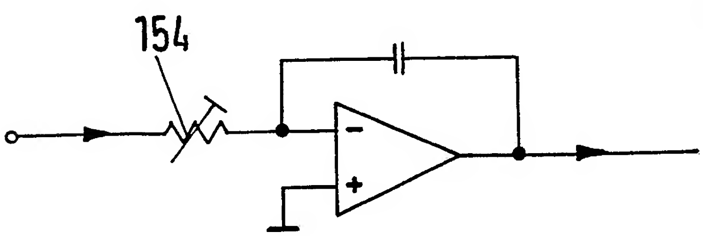
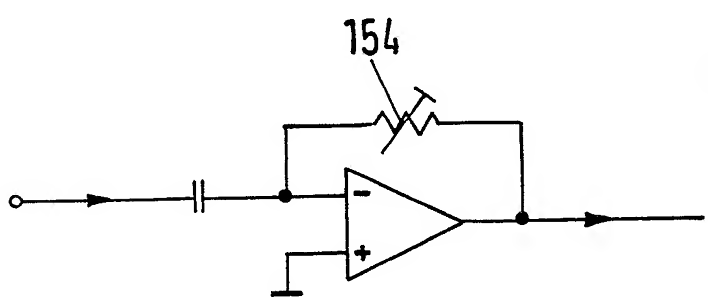
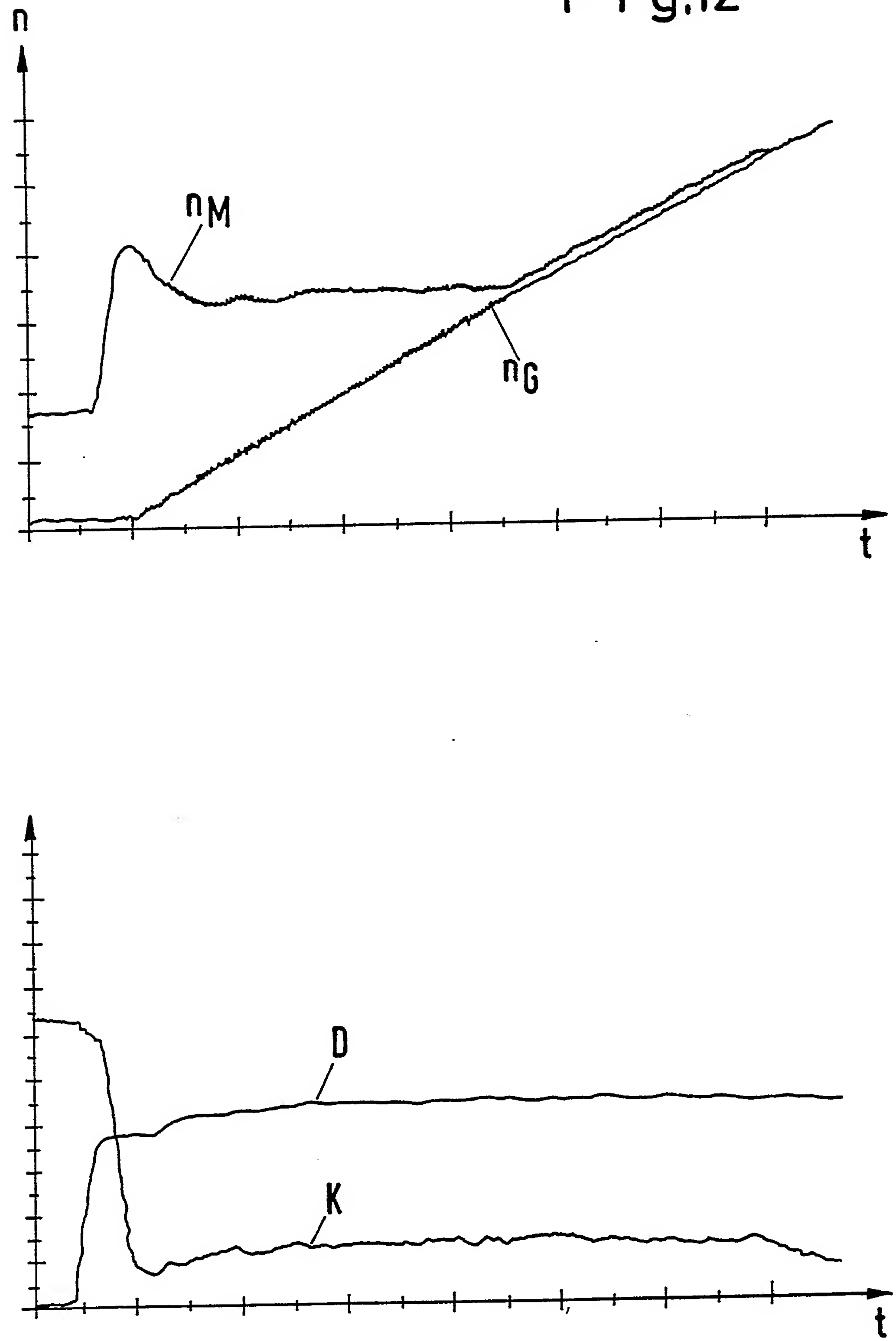


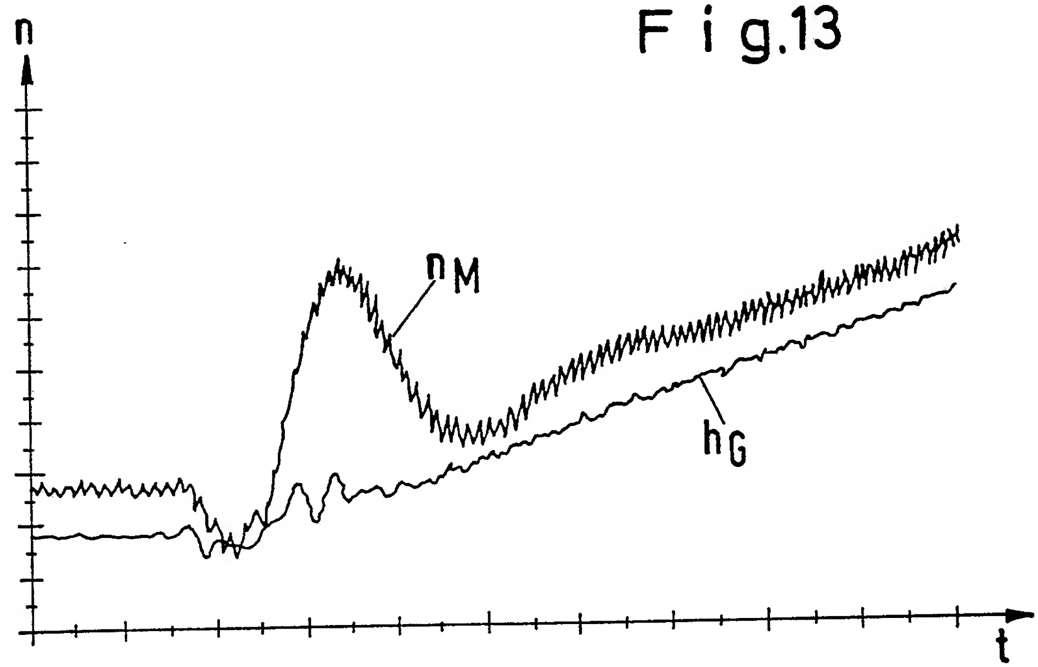
Fig.11



F i g.12



F i g.13



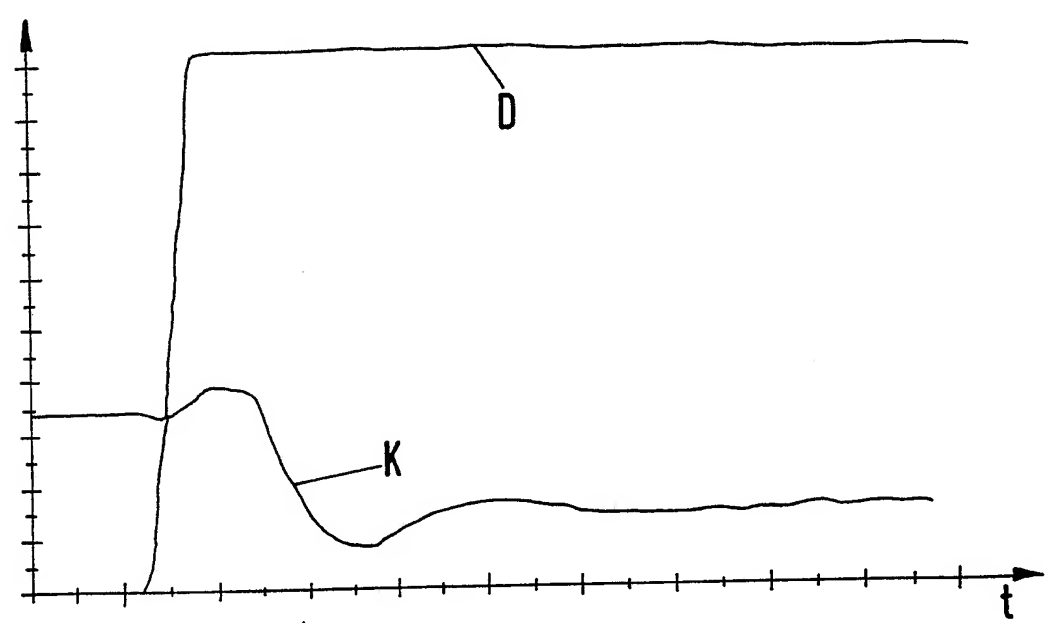
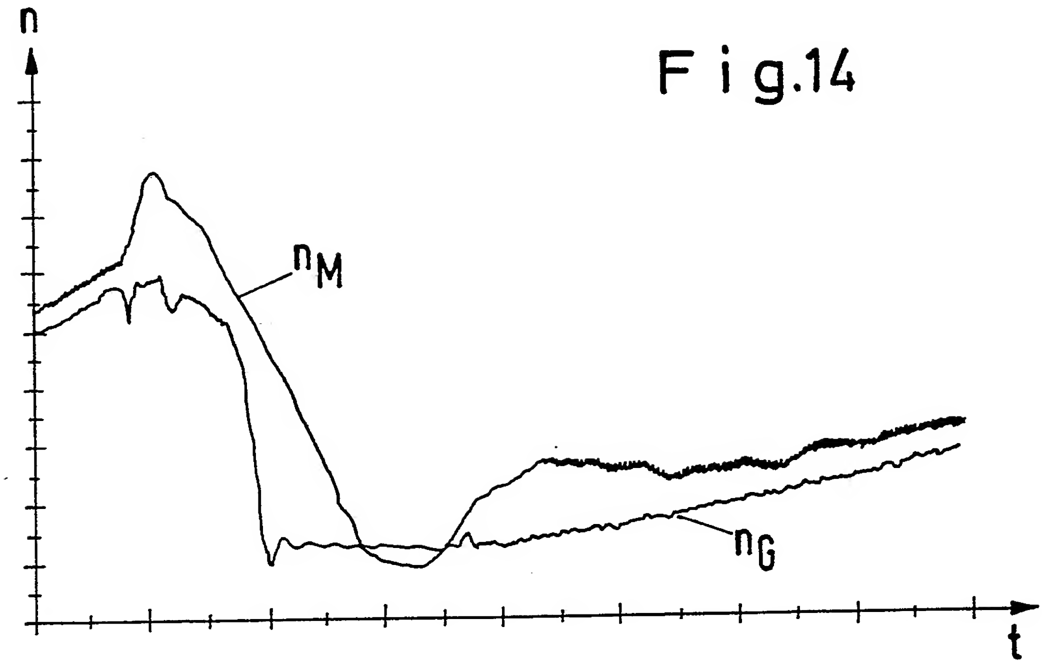
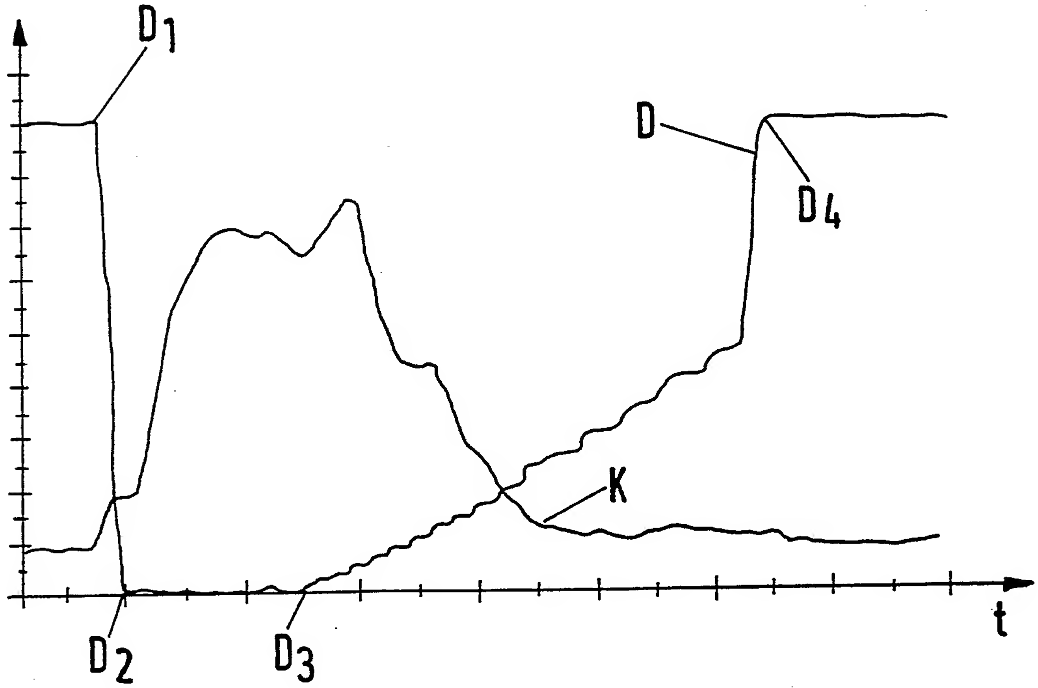
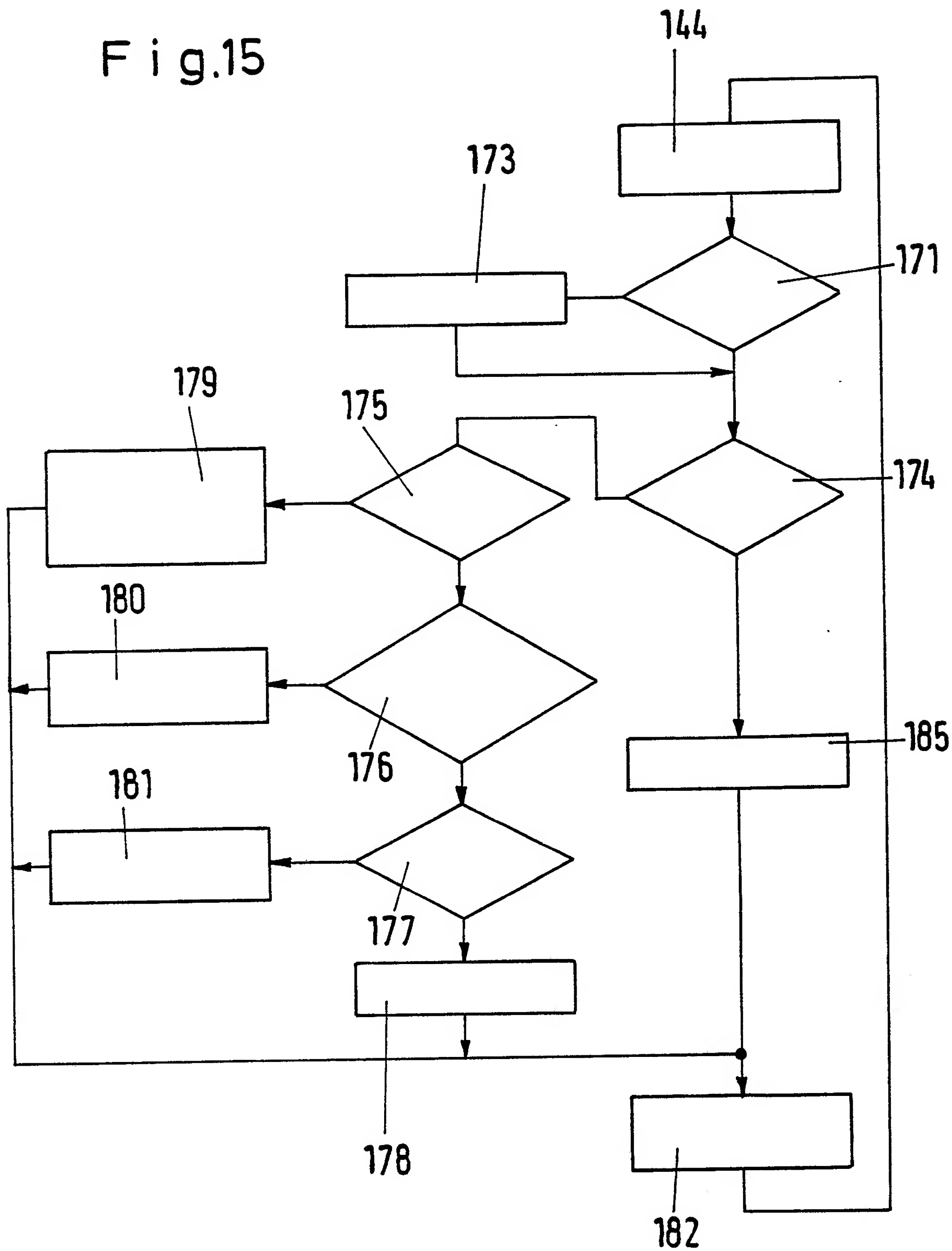


Fig.14





F i g.15



223116

Method for controlling an automatic friction clutch active between a drive machine and a gearbox and apparatus for carrying out the method as well as regulation for a friction clutch

The invention relates to a method for controlling an automatic friction clutch operating between a drive machine and gear box for at least one of the operational states, such as starting, changing gear, travelling, accelerating, braking, reversing, parking or the like and transitions between individual operational states.

Furthermore the invention relates to apparatus for carrying out the method for controlling an automatic friction clutch.

The invention also relates to a regulation for the transmission moment of a clutch between an engine and a gear box which can be used in connection with the method according to the invention and can be used with the apparatus according to the invention.

The object of the present invention is to provide a method and apparatus of the kind mentioned above through which it is possible to achieve with optimum driving comfort a consumption-favourable driving operation and/or optimum accelerations, smooth driving operation and long service life of the vehicle, more particularly the clutch.

The object of the invention is also to provide a regulation which with negligible dead time, thus each time within the operating periods,produces control values taking into account the operating parameters for regulating the transmission moment of a clutch.

This is achieved according to a variation of the method of the invention in that at least for the starting process a control engagement point of the clutch is detectable in dependence on a moment measurement carried out within the drive train and/or an angular measurement in that the clutch is closed from a disengaged position and with the gear engaged and the vehicle stationary at a defined speed up to a position where a moment is indeed introduced but this moment is less than that through which the vehicle would be moved, and a corresponding value, eg the path or location of the clutch actuation, on reaching a specific moment and/ or a specific angle, is detected and supplied to a memory whereupon the clutch is opened again at least partially, namely up to a defined waiting position where the clutch transfers no torque or only a very slight slipping moment.

According to a further variation of the method according to the invention, at least for the starting process, a control engagement point of the clutch is detectable in dependence on a gradient detection on rotatable components of the drive train in that the clutch is closed from a disengaged position and with the gear not engaged and the vehicle stationary at a defined speed up to a position where the gear input shaft is indeed driven but remains below the engine idling speed, and a gradient value which is present on reaching a certain state, such as a certain speed, and a value dependent on the state, such as the location of the clutch actuation are detected and supplied to a memory whereupon the clutch is opened again at least partially, namely into a waiting position where the clutch transfers no or only a slight slipping moment.

The aforementioned waiting position can also correspond to the fully disengaged state of the clutch. Also the pressure arising in the operating system which can be

hydraulic or pneumatic, can be detected in place of the path or location of the clutch actuation or additionally to same and established in the memory.

Further advantageous measures and developments of the method according to the invention are apparent from claims 2 and 4 to 64 wherein some of these measures and developments are inventive in themselves or at least in conjunction with the preamble of the independent claims.

For carrying out a method for controlling an automatic friction clutch a particularly advantageous apparatus is used which has at least some of the following gear change, measuring and regulating devices as well as at least one electronic unit with at least one computer and memory for preparing and storing the operating values or pulses detected by the devices and for controlling and regulating several of these devices.

a) means for detecting the engine speed, for example in the form of a sensor scanning the teeth on the flywheel disc

b) means for detecting the gear speed

c) means for measuring the clutch operating path, for example in the form of a potentiometer which detects the path of the clutch actuation member, such as for example a hydraulic receiver cylinder

d) means for detecting the position of the fuel supply mechanism, for example in the form of a potentiometer detecting the throttle valve position

e) means for detecting the accelerator pedal position in the form of for example a potentiometer controllable by the accelerator

f) a device for detecting the idling position of the fuel supply mechanism

g) means for detecting the gear position with neutral and gear detection

h) means for detecting the gear change intent in the form for example of a sensor provided in the gear selector lever

i) a device for detecting the throttle valve end position

j) a temperature measurer

wherein controllable by the electronics is at least

k) a clutch operating device, such as a hydraulic transmitter and receiver mechanism

l) a drive mechanism for altering the throttle valve position.

Furthermore it can be expedient if the apparatus for carrying out the method comprises a rotational direction detector or rolling direction detector eg according to claims 67 to 72. This type of detection is advantageous if the engaged gear and rolling direction of the vehicle do not agree. This is the case for example with a vehicle which - with first gear engaged is standing uphill, and moves downhill, thus rolls back. This detection can be carried out by means of a sensor. By detecting such cases

it is possible to avoid a regulator reaction which does not correspond to this state. This can happen for example in that in the aforesaid case, the detected gear speed receives a negative sign so that the regulation of the engagement state of the clutch required for this operating state and thus of the required slip speed is correctly carried out. Without detecting the direction it may happen that the slip speed is falsely calculated which would result in an unsatisfactory regulating condition and thus also engagements of the clutch.

The problem of regulating the transferrable moment of a clutch is solved according to the invention by the following features:

a) an actual slip is detected as the difference between the engine speed and gear speed;

b) a processor periodically questions input parameters, such as clutch path, throttle valve position (load), engine temperature and/ gear position, and by questioning stored characteristic fields determines an ideal slip and characteristic control factors;

c) a setting value for the clutch path is formed in a regulating path controlled by the control factors from the differential value between the ideal slip and actual slip.

The invention thus differs from the prior art in that the clutch is operated in dependence on the operating state of the engine with a slip. The transfer of engine vibrations to the drive train can thereby be substantially avoided. Optimization of the driving conditions is also possible.

Developments of the invention are given in sub-claims 75 to 88.

The invention will now be explained in detail with reference to Figures 1 to 15 in which:

Figure 1 shows diagrammatically the structure of a vehicle drive with a device according to the invention;

Figure 2 shows diagrammatically the structure of a hydraulic adjustment mechanism which is used with the device according to Figure 1;

Figure 3 is a circuit diagram of the electronic controls;

Figure 4 is a modified circuit diagram of the electronic controls;

Figure 5 shows the wave forms to explain the speed detection;

Figure 6 is a circuit diagram of a speed-dependent integrator;

Figure 7 is a circuit diagram of an absolute value detector;

Figure 8 is a block circuit diagram of the parameter-dependent control of a transmitter;

Figure 9 is a block circuit diagram of a P-member;

Figure 10 is a block circuit diagram of an I-member;

Figure 11 is a block circuit diagram of a D-member;

Figure 12 shows wave forms to explain a starting procedure;

Figure 13 shows wave forms for the regulating condition in the case of a rise in the load;

Figure 14 shows wave forms for a gear change process, and

Figure 15 is a simplified data flow chart for the data evaluation by the processor.

The apparatus 1 illustrated in Figure 1 for the drive of a motor vehicle comprises an engine 2 which can be connected in power engagement to the gear box 4 by a clutch 3. The gear box 4 is connected by a drive train 5 to the drive wheels 6 of the vehicle.

The friction clutch 3 can be engaged and disengaged by an operating mechanism 7 which can comprise a disengagement bearing and a fork engaging thereon. The operating mechanism 7 is operated by a setting member in the form of a hydraulic cylinder 8. The cylinder 8 is connected by a lead 9 to a hydraulic adjustment device such as a hydraulic setting member 10 which is shown in the principal structure in Figure 2.

To regulate the friction engagement of the clutch 3 an electronic unit 11 is provided which comprises at least one processor or computer and processes the values required to regulate the clutch 3 in order to set a corresponding clutch engagement through the hydraulic setting member 10.

The electronic unit 11 detects the values the speed of the engine 2, speed of the gear input shaft 12, position of the cylinder 8 and position of the throttle valve 13 (as well

as if necessary, further engine characteristic values such as operating temperature, air temperature, exhaust, fuel).

The electronic unit 11 is explained in connection with the block circuit diagram shown in Figure 3.

The engine speed is detected by a sensor 14 which scans for example the teeth 15 of the starter spur gear provided on the flywheel mass of the engine 2.

The gear speed is detected by a sensor 16 which scans the teeth 17 of a gear wheel provided on the gear input shaft 12.

The position of the fuel supply mechanism and throttle valve is detected by a sensor such as a potentiometer 18.

The drive or accelerator pedal 19 is in the present embodiment not coupled mechanically to the fuel supply mechanism 13 but by a setting mechanism such as a control circuit 20 which is controlled by the electronic unit 11 and has an electric servo motor.

To detect the gear means 22 are provided on the gear lever 21 which can also include a gear intent detection.

Through the gear intent detection which can be integrated into the means 22, the electronic unit 11 is advised whether the gear lever 21 is actually being moved in the direction where the next logical gear is located. If the lever is moved in the wrong direction, then this has no effect on the electronic unit 11, ie the clutch 3 is then only opened when the gear lever 21 is operated in the correct direction. Operating the gear lever 21 in a non-logical direction is thus not detected by the electronic unit 11 as a gear change intent.

To detect the clutch actuation path or clutch engagement state, means are provided to measure the path (path recorder), for example a potentiometer 23 which detects the path and position of the piston of the setting member 8 and sends a corresponding electric value to the electronic unit 11.

Instead of detecting the path and position of a clutch actuation means, the pressure arising in the hydraulic operating system could also be detected and processed accordingly through the electronic unit 11. For this it would only be necessary to replace the path recorder 23 by a pressure gauge which detects the pressure occurring in the hydraulic setting member 8 for example and converts it into a corresponding value which is sent to the electronic unit 11. In many cases it can also be advantageous if both a path measurement and a pressure measurement are carried out whereby the pressure measurement can be used in a particularly advantageous manner for adjusting the slip in the clutch since for this adjustment in part only very slight paths are covered by the setting member.

The hydraulic adjustment device 10 illustrated diagrammatically in Figure 2 has a hydraulic pump 26 which is drivable by an electric motor 25, is connected to an oil supply container 27 and which can impinge on the hydraulic cylinder 8 by a valve block 28. Integrated into the valve block 28 is an electromagnetically operated 3/3 control valve 29 with stabilizing spring which can be controlled by the electronic unit 11. The control valve 29 acts as a volume-proportional valve which means that the valve slide is displaced in dependence on the value notified by the electronic unit whereby the flow cross-section is varied accordingly. As an alternative a volume-proportional 4/4

valve or control valve controlled by a pulse width modulation could also be used.

A filter 30, non-return valve 31, pressure switch 32 which switches the engine 25 on and off as required, and a pressure accumulator are provided between the pump 26 and the control valve 29.

The pressure accumulator can be measured so that when the vehicle is operated at least a first disengagement is possible without a supply of energy so that no special motor 25 is required for the pump 26. When operating the internal combustion engine 2 the pressure accumulator 33 is supplied by a pump driven by the engine, such as the one operating the servo steering.

The functional operation of the unit 1 according to Figures 1 and 2 will now be described in detail.

When operating the internal combustion engine 2, thus with the vehicle stationary, as soon as the ignition contact is closed, the control valve 29 is controlled so that the clutch 3 is at first completely disengaged by way of the hydraulic cylinder 8 through the energy of the pressure medium available in the pressure accumulator 33. As soon as the engine 2 is started up and left idling, thus still no gear is engaged, the clutch 3 is closed from its disengaged position with a definite speed up to a position where the gear input shaft 12 is indeed driven but remains below the engine idling speed, and a specific gradient, such as for example speed gradient or angular acceleration gradient is sent by the sensor 16 to the electronic unit 11. As a result of the measured gradient, the engagement path of the clutch 3 covered until the said gradient is detected can be corrected in order to obtain a control engagement point. This control engagement point

corresponds to the position of the operating path of the friction clutch 3 at which a rapid engagement process takes place. On exceeding this control engagement point in the engagement direction of the clutch 3, a controlled engagement takes place. The detection of the control engagement point is necessary in order to eliminate substantially the effect of the manufacturing tolerances and thus to achieve an optimum clutch actuation for each vehicle. The engagement path of the clutch 3 covered up to the boundary gradient can be corrected on the basis of the gradient path up to the said boundary gradient so that in the case of a flat path of the gradient increase, a greater correction in the disengagement direction of the clutch 3 is made than in the case of a steep path of the gradient increase. A flat path of the gradient increase can be due for example to a clutch disc with a larger axial stroke so that when engaging the clutch the control engagement point is employed or reached earlier than in the case of a disc with little lateral stroke.

After the detected control engagement point the clutch is opened fully again.

As soon as the driver engages first or possibly second or reverse gear, the clutch 3 is closed by the hydraulic adjustment device 10 from the fully opened state at great speed to the control engagement point. If the driver now operates the accelerator pedal 19, a speed dependent on the position of the throttle valve 13 can be. determined from a characteristic field stored in the processor of the electronic unit 11 and a starting speed can be formed by adding on the present idling speed. This starting speed is adjusted by the control means 20 which operates the throttle valve 13. The controlled closing of the clutch 3 now takes place so that at a defined accelerator position the starting speed remains practically constant over the

entire engagement path. The optimum speed stored for starting can be that where the engine 2 provides the maximum moment for a preset throttle valve position. By closing the friction clutch 3 in this way it is possible to achieve a smooth even starting with optimum torque wherein stalling of the engine is virtually ruled out.

By considering the idling speed when detecting the starting speed, weather-conditioned factors can be taken into account since the idling speed is dependent for example on the temperature of the cooling water.

The controlled closing of the clutch 3 can take place until an ideal slip speed is reach or until the moment transferrable by the clutch 3 corresponds at least approximately directly to the moment produced by the engine 2. As an alternative the clutch 3 could also be closed completely.

When trying to start up in gears other than those provided for, the clutch 3 remains opened and the throttle valve 13 can be kept in the closed state by the control means 20 to avoid undesired revving of the engine.

The device 1 according to the invention is designed so that a certain slip between the engine 2 and gears 3 is always provided at least in the speed ranges of the engine where gearbox chatter or rattling of the bodywork could occur. The vibrations with ignition frequency which are superimposed on the engine speed in the case of vehicles with internal combustion engines are eliminated through this slip. The amplitude of these torsional vibrations is dependent on load so that it is expedient to change the slip speed in dependence on the load of the engine. The slip speed can thereby be in the order of between 10 and 100 revolutions per minute. The defined slip which is

possible through the clutch 3 acts as a deep pass and keeps the above described vibrations from the part of the drive train lying in the moment flow behind the clutch.

To regulate the slip, the speed of the engine 2 and gear input shaft 12 are measured by the sensors 14 and 16 and from this the differential speed is determined in the processor of the electronic unit 11. This detected differential speed is compared with an:ideal slip speed stored in the processor of the electronic unit 11 for the momentarily prevailing operating state of the vehicle and based on this result when required the actual clutch path or actual contact pressure of the clutch is brought to an ideal clutch path or ideal contact pressure whereby the friction engagement of the clutch 3 is altered to achieve the ideal slip speed. The ideal slip speeds associated with a specific operating state of the vehicle can be placed in the memory of the computer of the electronic unit 11 in the form of a 3D matrix of speed, load or accelerator position and engaged gear. However the ideal slip speeds can also be stored in table form, point form or as a function wherein the individual table values can be associated with a speed range, for example 100 revolutions. Thus for each translation ratio of the gear a table can be stored or a base table can be stored whose values are adapted by a correction factor corresponding to the gear engaged. A rotational direction or rolling direction detection can also be provided. Such a detection can be carried out for example by at least one sensor 35 which sends corresponding information to the electronic unit 11. The sensor 35 can thereby be integrated into an ABS system. Instead of the sensor 35, the sensor 16 could also be designed so that this not only detects the gear speed but also the rotational direction of the gears. A direction sensor of this kind makes it possible to detect those cases where the engaged gear and rolling direction do not

coincide. This is the case for example when the vehicle is standing uphill and moves downhill when first gear is engaged. By using a direction sensor it is possible to avoid false control reactions of the electronic unit 11. In those cases where the rolling direction and engaged gear do not coincide, the gear speed detected by the sensor 16 receives a negative sign so that the calculation of the slip speed is carried out correctly.

The slip control works during its operation mainly as a torque restrictor. Owing to driving at a predetermined slip speed, that is a predetermined slip speed is set by the control circuit, there is in the clutch practically a moment synchronization between the driving moment of the engine 2 and the slip moment of the clutch wherein the power used up by the slip plus the power delivered to the gears corresponds to the engine power. The slip moment is that moment which can be transferred to the vehicle for driving or acceleration. Through a burst of fuel more moments can now be suddenly delivered from the engine whereby the engine accelerates and increases its speed. This has the result that the clutch regulates more in the engagement direction. This takes place by the control circuit recognizing the higher/lower speed differential which occurs between the engine 2 and gears 4 and as a result a higher/lower contact pressure force is set in the clutch 3.

In several vehicles it is not necessary to drive permanently with slip for rattling or droning reasons,ie to have vibration insulation for the high-frequency engine vibrations, caused by the ignition sequence. If one drives in a range which is non.critical for rattling and droning, then the clutch 3 can be closed completely. By closing the clutch there is then no more wear but also no torque restricting operation. According to the invention in these

non-critical areas the moment transferrable by the clutch 3 is now adjusted to a value which is the same or only slightly greater than the moment arising of the engine 2. Since this engagement point of the clutch 2 can be detected by a moment measurement only at very high cost, with the device according to the invention the engagement point is determined by a speed measurement. For this at certain time intervals the clutch 3 is opened a little by the regulator, namely until a slight slip, for example in the order of 5 to 10 revolutions per minute is detected, and the clutch 3 then travels up to an engagement point at which the slip is no longer detected. This process can be carried out with a constant frequency. This method guarantees that a synchronized speed can be set between the engine 2 and gear input shaft 12 and also in practice a synchronized moment can be set between the moment delivered by the engine 2 and the transmission moment of the clutch 3. At a constant driving speed, thus with a practically constant accelerator position, scanning the engagement point at which the synchronized moment occurs, can be carried out with a relatively low scanning frequency. It is different when sudden moment jumps occur which means that the accelerator is suddenly depressed or let up.

With such sudden moment jumps the scanning rate must be considerably increased. For this the scanning rate can be changed in dependence on the speed at which the accelerator 19 or throttle valve 13 is moved. The latter can be carried out by means of a potentiometer 34 which detects the position of the accelerator 19.

Each location, that is each engaged position of the clutch 3 where the control has found a spot where there is no or only a very slight slip, can be fixed together with the throttle valve position associated with this spot in the memory of the computer of the electronic unit 11. With

sudden changes in moment, as a result of the new throttle valve position and stored values it can then be ascertained where the new slip point or moment balance point prevails.

As deviations occur, the values fixed by the electronic unit 11 where no or only a very slight slip occurs, are detected and corrected again, which means that the system is intelligent and capable of learning. Such deviations can occur for example as a result of a change in the friction value or in the contact pressure force whereby the control point at which no or only a very slight slip occurs is displaced. The engaged position of the clutch 3 detected for this control point can also be replaced by a pressure detection eg in the hydraulic cylinder 8. This engaged position can also be defined by means of a force measurement.

A possible design and functioning method of the electronic unit 11 will now be described in connection with Figures 3 and 5 to 15.

Input values for the electronic unit 11 are the engine teeth pulses of the teeth 15 of the flywheel which are moulded in an interface 124 and detected in a sensor 14. The frequency of the engine teeth pulses is thus proportional to the speed of the crankshaft. The pulses of the sensor 16 for the gear speed are moulded in an interface 125. The frequency of these gear teeth pulses is proportional to the speed of the gear input shaft.

The signals of the path receiver 23 for the clutch position are formed in an interface 126. The values of the sensor 18 for the position of the throttle valve are formed in an interface 127. The engaged gear recognition 22 supplies digital values for the engaged gear and if applicable for

the gear change intent when the gear lever is actuated. These values are processed in an interface 128.

The engine teeth pulses and gear teeth pulses must each be converted into speed-proportional analog values. For this stroke pulses of an oscillator 129 are used which operates with high frequency. In detail the preparation of the speed-proportional voltage values is each time carried out by means of a monoflop, more particularly a pre-settable meter 130 or 131 and integrator 132.

Figure 5 shows the pulse forms thereby occurring. In the first row, the stroke pulses To of the oscillator 129 are shown which occur with a constant high frequency.

The second row shows the engine teeth pulses Mz whose frequency is proportional to the engine speed. The number of teeth 15 on the engine flywheel disc has the value Zn. The presettable meter 130 is programmed to a pulse number Dm. It thus counts for each engine teeth pulse Mz the same number Dm of stroke pulses as engine stroke pulses MT. Each time there is an overrun, the output is switched over so that speed-proportional analog voltages are obtained. The output of the engine meter M is shown in the next row. The scanning ratio T of these pulses is proportional to the engine speed.

The following lines show the relevant gear teeth pulses Gz, the gear stroke pulses GT counted in the gear meter and the pulses occurring at the output of the gear meter G whose scanning ratio T is proportional to the gear speed. The number of teeth 17 has the value Zg. The gear meter is pre-programmed to the value Dg.

The following relations apply:

$$Um = K \times Dm \times Zm$$

$$Ug = K \times Dg \times Zg$$

wherein K is a proportionality factor. If the preset value for the engine counter is selected $Dm = K \times Zg$ and the preset value for the gear counter $Dg = K \times Zm$, then the above mentioned values Um for the engine speed and Ug for the gear speed can be standardized. The output pulses of the engine counter and gear counter are integrated in the integrators 132 and 133. These are compared with each other in a comparator so that a value or voltage for the speed difference or the actual slip of the clutch is obtained at the output of the comparator 134.

A speed-dependent integrator is used as the integrator 132 according to Figure 6 to dampen the ignition specific speed fluctuations of the engine speed and to reduce the time required to determine the engine speed. Figure 6 shows at the input the output voltage of the engine counter with the scanning ratio T. A switch 135 is switched over by the input pulses. The two integrators each have a resistance 136 with the value R_1 and 138 respectively with the value R_2 and a capacitor 137 with the value C_1 and 139 with the value C_2. The integration times are then each $t_1 = R_1 \times C_1$ and $t_2 = R_2 \times 1/T \times C_2$. When the switch 135 is closed by the output pulses of the engine counter, the dynamic resistance rises with a falling scanning ratio, thus lower speed. An extension of the integration time is thereby achieved at low speeds.

The absolute value of the slip is formed in a switching step 135. Details of these switching steps 135 are shown in Figure 7. The incoming slip-proportional voltage is compared with the zero value in a comparator 140. If the voltage is greater than zero then the position of the switch 141 remains unchanged so that the positive slip voltage is let through unchanged. If however the comparator detects a voltage value below zero then the

switch 141 is switched over and the voltage inverted in an inverter 142 is let through.

The slip values and the remaining input values are available in analog form and must be combined with ideal values and further control values. These ideal values and control values must be changed according to the operation. The detection and preparation of these values is undertaken by a processor 143 which contains a programmable computer unit and an address memory as the characteristic field memory. The characteristic field memory contains characteristic lines and characteristic fields for the slip which are laid down in dependence on load, in dependence on other engine parameters such as engine temperature, engine speed and the like and in dependence on the relevant gear position. The characteristic field memory contains values for the ideal slip and also control factors. The significance of these values and their processing is explained in the following.

The processor 143 controls a multiplexer 124 and an A/D converter 145 so that the different characteristic values can be processed in time-stacked manner. The analog values of the engine speed, gear speed, clutch position, throttle valve position and the like are converted into digital values which allow a control of memory addresses of the address memory within the processor 143. The questioned memory values of the stored characteristic field are issued as ideal slip values and converted into analog values in a D/A converter 146. The actual slip from the switching step 139 and the ideal slip from the converter 146 are compared with each other in a comparator 147 and produce a differential slip value which is then processed in control paths.

The corresponding control path comprises a P-branch 148 and an I-branch 149. The characteristic line or amplification of each control path can be controlled in dependence on parameters, as explained in Figure 8 in the main circuit diagram. Figure 8 shows a resistance 150 as well as a switch 151. The switch 151 is controlled by the output pulses of a timer 152 and is closed in the stroke of these timer pulses. The scanning ratio of the timer is controlled by digital setting values 153. The scanning ratio of the time 152 thus determines the closing time of the switch 151. The effective value of the resistance 150 is varied according to this closing time. This parameter-dependent resistance is illustrated in the following by the symbol 154.

Figure 9 shows the circuit diagram of a P-regulator with parameter-dependent resistance 154, Figure 10 the circuit diagram of an I-regulator with parameter-dependent resistance 154 and Figure 11 the circuit diagram of a D-regulator with parameter-dependent resistance 154. The parameters are represented by the setting values 153 and each change the chăracteristic line of the relevant control paths. These setting values or parameters are each questioned by the processor 143 in the characteristic field and if required are supplied after processing to the P-branch 148 and the I-branch 149 so that a temperature-dependent processing of the differential slip values takes place. The converted components of the differential slip value are added in an adding machine 155 and after amplification in an end step 156 are supplied as setting values to the setting member 10 for adjusting the clutch. A P-branch 148 and I-branch 149 are shown in Figure 3 for the slip regulation. If required, the regulation can also still contain a D-branch and/or other control branches.

The control parts described are required for regulating the slip of the clutch. They determine the relevant position of the clutch corresponding to the ideal slip.

In other driving conditions, a direct regulation of the clutch path independently of the slip is desired. This applies when starting up and when changing gear. For this a parameter-dependent control branch 157 is provided. For changing gear or other special operating conditions which are recognized by the processor during the course of the operation, ideal values for the clutch position are provided by way of a D/A converter 158 and compared in the comparator 159 with the actual value of the clutch position. The differential value is processed in the control branch 157 and fed into the setting member 10 in the manner described previously. If necessary a setting path controllable in dependence on parameters can also be used for a counter coupling in order to rule out oscillations in the regulation.

A throttle valve adjustment 162 is controlled by an end step 161 through the interface 128 for the gear position and detection of the gear change intent and during a gear change process the throttle valve adjustment moves the throttle valve into the closed position in order to prevent the engine from spinning.

To summarize, the input values are prepared in analog and after conversion to digital values are processed within the processor 143. The output values of the processor stored and possibly processed in the characteristic field are again converted into analog values and exist on the one hand as ideal values for the slip and coupling path and on the other hand as control parameters for the adjustment of the individual control branches. Through this design, an analog control is possible with variable regulating

characteristics in order to adapt the control each time to the different operating conditions in optimum manner. The control of the individual characteristic fields takes place on the basis of the input values of the control. Thus following the detection of an intent to change gear, the control is switched over from the slip control to the path control of the clutch. In the slip control operation the characteristic lines laid down are switched over in dependence on the engaged gear and/or load. The operating period of the processor 143 amounts to 5 ms so that a relevant alteration of the ideal values and control values is possible during the driving operation. The path control takes place when starting up, changing gear or exceeding a programmed maximum speed of the gear input shaft.

The interface 128 with the gear detection and gear change intent detection makes it possible to alter the relevant control sequences. When starting up,the ideal starting speed of the engine is determined in dependence on the position of the throttle valve and thus the desired acceleration and is kept constant by the control through a corresponding speed detection by altering the slip value. The idling speed is thereby also taken into account. Starting up is only possible in 1st or 2nd gear or reverse gear. When trying to start in other gears, the clutch remains opened so that starting is not possible through the control of the processor 143. During the actual process of changing gear, the throttle valve is closed and only opened when the gear is engaged. The relevant speed at which the clutch and throttle valve are adjusted during starting is restricted by the branch 160 in order to avoid excess reactions.

The ideal value of the slip normally amounts to 50 to 100 revolutions per minute. However other ideal values can also be stored in the characteristic field. In the high

speed range when the speed fluctuations of the engine are low or lie above the resonance frequencies of the chassis and bodywork, driving can be continued with zero slip. Below the aforementioned idling speed, the control works in the starting mode. Above the said speed, the clutch is completely closed and works without slip.

The behaviour of the control will now be explained with reference to Figures 12 to 14 for different driving conditions. Figure 12 shows the working of the control when starting up for partial load. The position D of the throttle valve is entered in the lower picture. The position D of the throttle valve indicates the desired acceleration and thus load. The control sets the required clutch path K corresponding to an ideal value for the engine speed NM. The engine speed NM and gear speed NG are entered in the upper picture. It is easy to see the even rise of the gear speed NG and thus the even starting behaviour of the vehicle.

Figure 13 shows the behaviour of the control in the event of a jump in the load without changing gear. The load jump passes from 0 to 100 %, as can be seen from the lower picture for the throttle valve position. The same applies to the slip control.

Figure 14 shows correspondingly a control characteristic line for a gear change process from second to third gear with full load. When detecting an intent to change gear (at D_1) the throttle valve is here automatically closed (at D_2) and after completing the gear change (from D_3) is slowly opened again accordingly up to full load (D_4) in order to avoid over-revving the engine. During the gear change process the clutch is changed over to path control. It is possible to see here the even path during the change-over process.

When switching off the engine, as the engine speed drops the clutch is closed completely and the corresponding clutch path measured. This value is stored in the characteristic field memory and is thus available as a basic value for the control.

The stored values can each be compared with the values actually detected and can be stored in the characteristic fields. Thus it is possible to adapt the stored values to the actual operating state, more particularly the state of wear of the clutch.

Figure 4 shows a modified embodiment of the control. Input values for the electronic unit 11 (in Figure 1) are the engine teeth pulses of the teeth 15 of the flywheel formed in an interface 124 and detected by a sensor 14. The frequency of the engine teeth pulses is proportional to the speed of the crankshaft. The pulses of the sensor 16 for the gear speed are formed in an interface 125. The frequency of these gear teeth pulses is proportional to the speed of the gear input shaft.

The signals of the path receiver 23 for the clutch position are formed in an interface 126. The values of the sensor 18 for the position of the throttle valve are formed in an interface 127. The gear detection 22 supplies digital values for each gear engaged and where applicable for the gear change intent when the gear lever is operated. These values are processed in an interface 128.

The time intervals between two successive engine and gear pulses are each measured in the counter 130 or 131, Stroke pulses of an oscillator 129 operating with high frequency are used for this. The states of the counters are read by the processor 143, they are inverted proportional to the

speed. The processor 143 controls a multiplexer 144 and an A/D converter 145 so that the different characteristic values can be processed in time-staggered manner. The clutch position, throttle valve position and the like are converted into digital values.

The processor 143 contains an address memory as the characteristic field memory. The characteristic field memory contains characteristic lines or fields for the slip which are dependent on load, dependent on the relevant gear position and if required dependent on other engine parameters. The characteristic field memory contains values for the ideal slip and also control factors.

The processor 143 calculates from the states of the counters 130 and 131 the engine speed and gear speed and from this the actual slip. The actual slip and ideal slip from the characteristic field are compared in the computer mechanism of the processor 143 and produce a differential slip value which is processed further by computer. Through known arithmetical processes, a P-branch and I-branch are reproduced and calculated in the processor 143. If required, the calculation can also still contain a D-branch and/or other control branches.

With the control according to Figure 4 no analog control paths are required since this control is reproduced by a program cycle of the processor 143. The program sequence of the processor 143 can follow according to the flow chart of Figure 15. It is possible to see in this flow chart the preparation of the input values controlled by the multiplexer 144, such as the speed, clutch position, throttle valve position, gear detection and the like. In a first branch stage 171 the engine speed is questioned and compared with a minimum value which occurs when switching off the engine below the idling speed. When this minimum

value of the speed is understepped, according to the program part 173 the clutch is engaged completely and the zero point of the clutch path determined. This zero point of the clutch path is stored in the characteristic field. From the design values of the clutch the disengagement point of the clutch is produced from this zero point of the clutch path and the control of the clutch path takes place accordingly.

In the next branch 174 any intent to change gear which is present is examined. If there is an intent to change gear, then according to program part 185 the clutch is completely disengaged so that changing of the gear can be completed. If there is no intent to change gear or if the gear is engaged in the desired gear, then according to branch 175 an examination is carried out to see whether the neutral gear or idling is engaged. In first gear and/or in reverse gear as well as with gear speeds below a minimum value, a control for starting is carried out according to branch 176. Then with an open throttle valve the starting process is finally triggered according to branch 177. Moreover during each program cycle corresponding to branch 175 the engagement point is detected according to the program part 179, just as the idling speed and the clutch is again completely disengaged.

The branch 176 leads on the other hand to the program part 180 according to which is controlled the ideal slip of the clutch. Finally disengagement is carried out up to the engagement point according to the branch 177 in the program part 181. The weight parameters for the control paths are prepared in the program part 182.

The reproduction of the control branches through a program sequence each time calculates the input values of the control branches and a product with a factor from the

characteristic field memory. The different product values are added. A damping branch is brought about by a difference between the values calculated in successive computing periods. The computing periods should be about 3 ms.

The processor 143 carries out the said calculations and sends the output values to an end step 183 which controls the setting member 10 to control the clutch. The end step can contain a DA converter. A pulse generator with controlled scanning ratio can also be provided.

Claims

1. Method for controlling an automatic friction clutch operating between a drive machine and a gearbox for at least one of the operational states such as starting up, changing gear, travelling, accelerating, braking, reversing, parking or the like and transitions between the individual operational states respectively characterised in that at least for the starting process a control engagement point of the clutch is detectable in dependence on a moment measurement carried out within the drive train and/or an angular measurement in that the clutch is closed from a disengaged position and with the gear engaged and the vehicle stationary at a defined speed up to a position where a moment is indeed introduced but this moment is less than that through which the vehicle would be moved, and a corresponding value, eg the location of the clutch actuation, on reaching a specific moment and/or a specific angle, is detected and supplied to a memory whereupon the clutch is opened again at least partially (waiting position).

2. Method according to claim 1 characterised in that the angular measurement is carried out between an input and output element of one of the clutch components such as the friction linings and hub of the clutch disc.

3. Method for controlling an automatic friction clutch operating between a drive machine and a gearbox for at least one of the operational states such as starting up, changing gear, travelling, accelerating, braking, reversing, parking etc and transitions between individual operational states, characterised in that at least for the starting process, a control engagement point of the clutch is detectable in dependence on a gradient detection on rotatable components of the drive train, in that the clutch

is closed from a disengaged position and with the gear not engaged (and the vehicle stationary) at a defined speed up to a position where the gear input shaft is indeed driven but remains below the engine idling speed, and a gradient value which is present on reaching a certain state, such as a certain speed, and a value dependent on the state, such as the location of the clutch actuation are detected and supplied to a memory whereupon the clutch is opened again at least partially (waiting position).

4. Method according to claim 3 characterised in that the detected clutch actuation spot is corrected according to the detected gradients in order to determine the control engagement point.

5. Method according to one of claims 1 to 4 characterised in that closing the clutch is carried out in dependence on the engagement of a gear from the waiting position up to a control engagement point at a defined speed and from the control engagement point in dependence on the accelerator position a regulated closing of the clutch takes place so that the engine speed is adjusted to an ideal speed associated with each accelerator pedal position and stored in a memory.

6. Method according to claim 5 characterised in that the engine speed is kept at least substantially constant.

7. Method according to claim 5 or 6 characterised in that the engine speed is derived from a stored characteristic field which contains the ideal engine speeds which correspond to each throttle valve position and to the maximum engine moment.

8. Method according to one of the preceding claims characterised in that the actual engine idling speed which

is dependent on the engine temperature is detected in dependence on the engaged neutral gear and the closed throttle valve and is increased by a differential amount associated with the corresponding temperature.

9. Method according to claim 8 characterised in that the starting speed in dependence on an engaged gear, opened throttle valve and reaching the preset increased speed value releases the starting process wherein the engagement of the clutch can be controlled from the control engagement point.

10. Method according to claim 3 or following characterised in that the gradient is detected from the speed such as the speed of the gear input shaft.

11. Method according to claim 3 or following characterised in that the gradient is detected from an angular acceleration (an angular speed measurement).

12. Method according to claim 3 or following characterised in that a gradient is detected from a moment build-up.

13. Method according to one of claims 3 or following characterised in that the gradient is detected in dependence on the run-through time of a certain speed range and on reaching the upper speed range.

14. Method according to one of claims 1 to 13 characterised in that the clutch is opened by a constant path in dependence on the control engagement point.

15. Method according to one of claims 1 to 14 characterised in that the clutch is opened the maximum disengagement path in dependence on the control engagement point.

16. Method according to at least one of the preceding claims, characterised in that the control engagement point is further away from the point remote from the closed state of the clutch (zero) the flatter (slower) the rise in the gradient.

17. Method according to one of the preceding claims characterised in that the clutch is closed (neutral position) in dependence on the stationary engine.

18. Method according to claim 17 characterised in that the clutch path corresponding to the neutral position is fixed in a memory.

19. Method according to at least one of the preceding claims characterised in that when the engine starts the clutch is opened the maximum disengagement path, closed at least up to the detection of the control engagement point, a value corresponding to this is fed to a memory and the clutch is opened again up to the waiting position.

20. Method according to at least one of the preceding claims characterised in that at least during the starting process, the detected gear and/or engine speed is smoothed out by means of a filter, more particularly a 'deep fit filter'.

21. Method according to claim 20 characterised in that the filter is a so-called "co-rotating" or "flying" filter.

22. Method according to in particular one of the preceding claims, characterised in that when travelling a slip in the clutch is regulated at least over parts of the speed range of the engine.

23. Process according to claim 22 characterised in that a (slight) slip is regulated permanently.

24. Method according to claim 22 or 23 characterised in that the slip is variable.

25. Method according to claim 24 characterised in that the slip is variable in dependence on the engine speed.

26. Method according to one of claims 22 to 25 characterised in that the slip is variable in dependence on the moment transferred.

27. Method according to one of claims 22 to 26 characterised in that the slip is variable in dependence on the throttle valve.

28. Method according to one of claims 22 to 27 characterised in that the slip is controllable dependent on the gear.

29. Method according to one of claims 22 to 28 characterised in that the slip can be changed to an ideal slip associated with each operational state of the vehicle such as the engine, clutch or throttle valve or the like, and filed in a memory.

30. Method according to one of claims 22 to 29 characterised in that the variation in the slip is stored in the form of a characteristic field, table or characteristic curve.

31. Method according to one of claims 22 to 30 characterised in that the clutch is closed (further) in dependence on an increasing slip.

32. Method according to one of claims 22 to 31 characterised in that the clutch is opened (further) in dependence on a reducing slip.

33. Method according to at least one of the preceding claims characterised in that the slip can be changed by altering the contact pressure of the clutch.

34. Method according to in particular one of the preceding claims, characterised in that when travelling, at least over sections of the speed range of the engine, the moment transferred by the clutch is regulated in dependence on operating parameters, such as the position of the accelerator pedal, to a value which is as near as possible the same as the engine moment arising (moment equality).

35. Method according to one of the preceding claims, characterised in that in the case of a fixed slip, the transferrable moment of the clutch (such as the clutch path, clutch contact pressure or the like) is changeable until the slip is at least more or less eliminated (moment equality).

36. Method according to at least one of the preceding claims, more particularly claim 34 characterised in that operational parameters, such as the accelerator position, clutch path, clutch contact pressure or the like which exist with an at least approximate moment equality between the drive and driven side of the clutch, are fixed in a memory.

37. Method according to one of the preceding claims, characterised in that the parameters at which the slip is practically "nil" are stored in the form of a characteristic field or characteristic curve.

38. Method according to one of claims 34 to 36 characterised in that at least with an approximate moment equality the clutch is opened (slightly) at certain time intervals until a (slight) slip is detected after which the clutch is closed again until at least a lower (none) slip is detected.

39. Method according in particular to claim 38 characterised in that the time intervals are variable in dependence on the operational states of the engine and vehicle.

40. Method according in particular to claim 39 characterised in that in the case of a practically constant moment path in the drive train, such as a constant engine load, the time intervals are greater than in the case of changes, more particularly sudden changes, in the moment.

41. Method according to one of claims 38 to 40 characterised in that the time intervals are dependent on the speed with which the accelerator position is changed.

42. Method according to one of claims 1 to 41 characterised in that the detected and stored data, such as for example, the control engagement point, neutral point, waiting position, slip, moment equality point or the like are brought up to date on the basis of each new item detected.

43. Method according in particular to claim 42 characterised in that each last item of data detected is compared with the stored data and exchanged for this if there is any deviation.

44. Method according to claim 42 or 43 characterised in that each last item of data detected is compared with the

corresponding stored data and a plausibility check is carried out.

45. Method according to one of the preceding claims, characterised in that a mean value is formed from several detected items of data of the same kind and this is then stored.

46. Method according to one of the preceding claims, characterised in that the stored engine speed associated with each specific accelerator position is corrected in dependence on the engine temperature at least for the starting process.

47. Method according to one of the preceding claims, characterised in that the detection of the idling speed is carried out with an open clutch in the idle state or with the gear engaged and/or the clutch closed in the idle state and the accelerator not activated.

48. Method according in particular to one of the preceding claims, characterised in that the clutch is opened quickly temporarily in dependence on a sudden change in load, such as the transition from the traction to the thrust direction (in order to prevent a sticking phase as the slip passes through zero).

49. Method particularly according to claim 48 characterised in that the speed of the change of load is detected as a result of the speed of the change in the accelerator position and/or the change in engine speed.

50. Method according to claim 49 characterised in that the clutch is first opened up to the control engagement point and when the accelerator pedal is partially actuated the

clutch is closed again up to the engagement point corresponding to the position of the accelerator.

51. Method according to claim 48 or following characterised in that during the thrust operation when the accelerator is not operated, the clutch opens up to the control engagement point.

52. Method according to one of the preceding claims, characterised in that starting up is only possible in the first gear and/or in second gear and in reverse gear.

53. Method particularly according to at least one of the preceding claims, characterised in that when changing gear when driving, the fuel supply device is returned to the idling position without the driver having to take his foot off the accelerator, furthermore the clutch is opened and after completing the gear change the clutch is again definitely closed and the fuel supply device again opens to the position corresponding to the relevant accelerator position.

54. Method according to at least one of the preceding claims, characterised in that the state of wear of the friction clutch is monitored through the detected and stored marks such as the neutral point, control engagement point, waiting position, and when a limit value is reached this is indicated.

55. Method according to at least one of the preceding claims, characterised in that the energy which arises as a result of a slip in the friction clutch is detected and when a limit value is exceeded a warning is given and/or the clutch engagement state is changed.

56. Method according to claim 55 characterised in that on exceeding the limit value the clutch is closed or opened at a defined speed in order to reduce the friction energy which is arising.

57. Method according to claim 55 characterised in that on reaching a limit value, an automatic gear change is recommended and with an automatic gear box is automatically carried out, for example into the next gear down.

58. Method according to one of claims 55 to 57 characterised in that to detect the friction energy occurring in the clutch the product of the slip and transferred moment is integrated over the time.

59. Method according to claim 58 characterised in that the detected friction energy in definite time intervals is reduced by a cooling constant.

60. Method for controlling an automatic slip clutch for or during the gear change, particularly according to one of the preceding claims, such as claim 53, characterised in that on operating the gear lever the clutch is opened, after engaging gear the controlled closing of the clutch is introduced by regulating the speed of the engagement process according to the position of the accelerator.

61. Method according to claim 60 characterised in that the fuel supply is regulated in dependence on the speed of the engagement process.

62. Method particularly according to one of claims 1 to 61 characterised in that a hydraulic volume-controlling proportional valve (such as a 4/3 or 3/3 way valve) is provided as the operating mechanism for the clutch.

63. Method according to one of claims 60 to 62 characterised in that a hydraulic volume-proportional servo valve integrating in respect of the clutch position is provided as the clutch operating mechanism.

64. Method, particularly according to one of the preceding claims, such as claim 60 or following, characterised in that the clutch is only disengaged for changing gear when the gear lever is loaded or moved in a direction which corresponds to the stress or movement of the lever from the engaged gear position into the next or previous gear position.

65. Apparatus for carrying out the method according to claim 64 characterised in that the signal to open the clutch is fed to the clutch activator in dependence on the engaged gear (gear detection unit) and in dependence on the operation or load of the gear lever towards the next or preceding gear stage (gear change intent recognition).

66. Apparatus for carrying out the method for controlling an automatic friction clutch, particularly according to one of the previous claims, characterised by at least some of the following listed change, measuring and regulating devices as well as electronic unit with at least one computer and memory to which is connected at least

a) means for detecting the engine speed, for example in the form of a sensor scanning the teeth on the flywheel disc
b) means for detecting the gear speed
c) means for measuring the clutch operation path, for example in the form of a potentiometer which detects the path of the clutch operating member, such as for example a hydraulic receiver cylinder

d) means for detecting the position of the fuel supply mechanism, for example in the form of a potentiometer detecting the throttle valve position

e) means for detecting the accelerator pedal position in the form of a potentiometer for example controllable by the accelerator

f) a device for detecting the idling position of the fuel supply device

g) means for detecting the gear position with neutral and gear detection

h) means for detecting the gear change intent in the form of a sensor on the gear stick,for example

i) device for detecting the throttle valve end position

j) a temperature measurer

wherein controllable by electronics is at least

k) a clutch operating device such as a hydraulic transmitter and receiver mechanism

l) a drive mechanism for altering the throttle valve position.

68. Apparatus for carrying out the method according to one of the preceding claims, characterised in that it comprises a rotational direction detector.

69. Apparatus according to claim 67 characterised in that the rotational direction detector interacts with the gearbox input shaft.

70. Apparatus for carrying out the method according to at least one of the previous claims 1 to 69 characterised in that it comprises a rolling direction detector.

71. Apparatus according to one of claims 67 to 70 characterised in that the rotational direction detector and the rolling direction detector form one unit.

72. Apparatus according to one of claims 66 to 71 characterised in that it also comprises an ABS system which is used to detect the rotational direction.

73. Regulation for the transmission moment of a clutch between an engine and a gearbox, particularly for carrying out the method according to one of claims 1 to 64 characterised by the following features:

a) an actual slip is determined as the difference between the engine speed and gear speed;
b) a processor periodically questions input parameters such as the clutch path, throttle valve position (load), engine temperature and/or gear position, and determines by questioning stored characteristic fields an ideal slip and characteristic control factors;
c) a setting value for the clutch path is formed from the differential value between the ideal slip and actual slip in a regulating path controlled by the control factors.

74. Regulation for the transmission moment of a clutch between an engine and a gearbox, characterised by the following features:

a) an actual slip is determined as the difference between the engine speed and gear speed;
b) a processor periodically questions input parameters such as the clutch path, throttle valve position (load) engine temperature and/or gear position and with any alteration in the load determines a clutch ideal path and characteristic control factors;
c) the clutch path ideal value and the clutch path actual value are compared with each other and a setting value is formed for the clutch path.

75. Regulation according to claim 73 or 74 characterised in that to measure the speed of the engine and/or gear the relevant tooth pulses provide a presettable meter, high-frequency stroke pulses are counted in this presettable meter and the output pulses of the presettable meter have a speed-proportional stroke ratio.

76. Regulation according to claim 75 characterised in that each preset value, the meter for the engine stroke pulse and the meter for the gear stroke pulse are selected taking into account the relevant tooth number to standardize the speed values.

77. Regulation according to claim 75 or 76 characterised in that the output pulses of each presettable meter are integrated in a speed dependent integrator to form a speed·proportional analog voltage.

78. Regulation according to claim 77 characterised in that the integrator comprises in series two RC members and between these an electronic switch controlled by the output pulse of the presettable meter.

79. Regulation according to claim 78 characterised in that to form the absolute value of the actual slip an inverter comprises a switch for switching between the actual slip values and the inverter output, and a comparator for controlling the switch.

80. Regulation according to one of claims 76 to 79 characterised in that the output values of the integrators are compared in a comparator to form an actual slip.

81. Regulation according to one of claims 73 to 80 characterised in that the analog input values are each converted in an A/D converter into digital values which

serve as the input values for questioning the characteristic fields.

82. Regulation according to claim 81 characterised in that the processor comprises a multiplexer for the time-staggered questioning and processing of the values.

83. Regulation according to one of claims 73 to 82 characterised in that the output values of the processor are each converted in an D/A converter into analog values for ideal slip, ideal clutch path and control characteristic values.

84. Regulation according to claim 82 or 83 characterised in that a setting value is detected from the actual values and ideal values in a comparator.

85. Regulation according to one of claims 81 to 84 characterised in that each control circuit for processing a setting value contains an electronic switch which is controllable by pulses with controlled stroke ratio according to each characteristic field value and the desired control characteristic line.

86. Regulation according to one of claims 73 to 85 characterised in that a sensor is provided to detect a gear change intent which causes closing of the throttle valve and regulation of the clutch path.

87. Regulation according to one of claims 73 to 86 characterised in that the path regulation for the clutch path comprises a feedback branch for defining the displacement speed.

88. Regulation according to one of claims 73 to 87 characterised in that in the parking phase of the engine

the zero point for the clutch path is determined by a complete engagement of the clutch and is stored in the characteristic field.

Published 1990 at The Patent Office, State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from The Patent Office.